Renewable and Sustainable Energy Reviews 15 (2011) 4118–4124

Contents lists available at ScienceDirect

Renewable and Sustainable Energy Reviews

journal homepage: www.elsevier.com/locate/rser

The impact of household behavioral changes on GHG emission reduction in Lithuania

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ARTICLE INFO

Article history:
Received 10 January 2011
Accepted 5 July 2011
Available online 21 August 2011

Keywords:
GHG emission reduction
Energy saving
Behavioral changes

ABSTRACT

It is commonly understood that households must change their behavior to reduce problems related increased energy consumption and climate change therefore in the search of cheap GHG emission reduction measures households are an important target group because they are responsible for more than 20% of total energy consumption in developed countries. In addition waste management and responsible consumption of products are the key issues in GHG emission reduction.

The aim of the paper is to assess GHG emission reduction potential in households in terms of behavioral changes towards sustainable consumption. The review of literature on analysis of households behavioral changes impact on GHG emission reduction was performed; the daily survey of household agenda and energy use records were performed in Lithuania for two scenarios – baseline and GHG emission reduction scenario including energy saving. GHG emission reduction potential in household was assessed based on daily survey data and energy consumption records by applying carbon calculator based on modified coefficients. Evaluated GHG emission reduction potential in households was compared with GHG emission reduction potentials in other sectors of Lithuania. Based on analysis performed in the paper the tools to promote household behavioral changes towards sustainable consumption were proposed.

Contents

1. Introduction

GHG mitigation policies require an understanding not only of just economics but also of behavioral and psychological factors. Behavioral experiments show that the monetary initiatives are not enough to implement climate change mitigation policies. All environmental policies involve some notion of the economic good. Scientists proved [1,2] that giving people a shared responsibility and appealing directly to a sense of the common good are much more effective ways of gaining acceptance for climate change mitigation and other environmental policies [3].

Fossil fuel burning is the main sources of GHG emissions [4]. The major source of GHG in Lithuania is energy sector, which is responsible for 61% of all GHG emissions (in Gg CO_2 equivalent), not taking into account removals/emissions from LULUCF sector [5].

Households consume 1/3 of total energy consumption in EU. Household greenhouse gas emissions are directly related to the amount of energy consumed in households. However, different fuel sources have different greenhouse gas intensities. For example, electricity used from coal-fired power stations is far more greenhouse-polluting than the usage of gas delivering the same amount of useful energy. Within each area of household energy use, there will be different strategies for the reduction of emissions through changes to the house fabric, changes in behavior and purchasing, and energy conservation applied to existing appliances [6].

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doi:10.1016/j.rser.2011.07.027

Houses, appliances and the energy type they use give rise to a huge variation in regional household emissions. Nationally, a typical household using predominantly electric appliance may contribute up to 10 tonnes of carbon dioxide per year while a house with many gas appliances may produce over 6 tonnes of carbon dioxide per year. According [7] 29% of average household energy consumption is used for water heating, 16% by refrigeration, 14% by space heating and cooling, 8% for lighting, and over 7% for standby power [8,9].

However few places are average and household consumption is determined by geographical region, income, climate and building stock as well as by personal behavior and equipment [10]. The right choices for residential measures can significantly to reduce GHG emissions in households and help country to achieve GHG emission reduction targets set by international commitments including UNFCCC Kyoto protocol and following international climate change mitigation regimes after Kyoto. Seeking to evaluate possibilities of households to reduce GHG emissions by behavioral changes the comprehensive study was conducted by MSc programme students at Vilnius University, Kaunas Faculty of Humanities in 2009. 50 households were surveyed [11].

The aim of the paper is to assess GHG emission reduction potential in households in terms of behavioral changes towards sustainable consumption. The main tasks to achieve this target are:

- To review literature on analysis of households behavioral changes impact on GHG emission reduction.
- To conduct the daily survey of household agenda and perform records of energy use and other habits based on two scenarios – baseline and GHG emission reduction scenario including energy saving and evaluation of avoided GHG emissions in warm and cold periods of the year.
- To evaluate GHG emission reduction potential in household by applying carbon calculator based on modified coefficients.
- To compare GHG emission reduction potential in households with GHG emission reduction potentials in other sectors in Lithuania.
- Propose tools to promote household behavioral changes towards sustainable consumption.

2. Review of literature on behavioral changes impact on GHG emission reduction

Economists using evidence from behavioral economics suggested a redirection of public policy from supply side to demand side measures [12–14,3]. Very practical examples of using behavioral understandings to inform policy include the design of energy savings plans and improving the reliability of identification in policy line-ups. Intergovernmental Panel on Climate Change (IPCC) has established the task to address lifestyles and environmental behavior in the Fifth Assessment Report of IPCC upcoming in 2014 [15]. In addition behavioral economics plays important role in modern economic research [16–18].

Recent studies in this area revealed that variation across countries in quantity of energy used per capita, which is large both at economy and household levels can be explained only partly by weather and wealth; this is also appropriately attributed to different lifestyles [19–24]. Even in identical houses with the same number of residents, energy consumption has been shown to differ by a factor of two or more [25]. Studies aimed at understanding these issues suggest that while lifestyle, traditions and culture can act as barriers, retaining and supporting lower-consuming lifestyles may also be effective in constraining GHG emissions. Another important problem is the ‘rebound effect’. This takes place when increased energy efficiency is accompanied by increased demand for energy services [26].

The potential impact of lifestyle and tradition on energy use is most easily seen by cross-country comparisons. For example, dishwasher usage was 21% of residential energy use in UK residences in 1998 but 51% in Sweden. Cold water is traditionally used for clothes washing in China [27] whereas hot water washing is common in Europe. Similarly, there are substantial differences among countries in how lighting is used at night, room temperatures considered comfortable, preferred temperatures of food or drink, the operating hours of commercial buildings, the size and composition of households, etc. [28].

The user behavior is dependent on information, motivation and responsibility. All these factors have to be addressed by several instruments like incentives for energy savings (e.g. financially), energy consultancy (as mandatory during construction and installation of appliances) and information given by campaigns, publications, workshops, feedback projects (energy demand per hour/saving potential by behavior) and lighthouse projects to increase information and interest since the general public opinion is important to trigger the consumer’s behavior which plays a major role for individual energy savings. As information about energy-efficiency options is often incomplete, unavailable, it is particularly difficult to learn about the performance and costs of energy-efficient technologies and practices, because their benefits are often not directly observable. For example, households typically receive an energy bill that provides no breakdown of individual end-uses and no information on GHG emissions. It is necessary to provide sufficient feedback to consumers on their energy use and on the potential impact of their efficiency investments.

Energy saving and GHG emission reduction in household can be achieved by two different ways: by the behavioral changes or process innovations and by implementing product’s innovations [19,24,2]. The behavioral changes are first of all related with implementation of principles of sustainable consumption [20,3]. Product innovations are related with the replacement of not energy efficient appliances or cars by new one, consequently more advanced in terms of energy saving, renovation of buildings, etc. [29]. The product innovations are related with some costs; however, the behavioral changes can be achieved at no or negative costs and no harm for well-being [30,31].

Important factors influencing the behavior are the grade of information, the awareness and the attitude. It is hereby interesting that the energy saving behavior of people, their awareness and their attitude about environmental problems are often not consistent. As shown in some studies the relation between the individual attitude and the behavior is much stronger when the broad focus (e.g. climate change) becomes an immediate personal meaning (e.g. concerning health or economical incentives). Other socio-demographic and psychological factors influencing the indoor energy consumption are: gender, age and socio-demographic conditions [19,20,22–24].

It was evaluated that an effective consumer-oriented climate policy requires knowing the GHG reduction potential of sustainable consumption. GHG emission reduction potential in Switzerland makes 5–17 tonnes of CO_2-equivalent per capita and year. The observed differences stem mainly from heating, electricity use, car use, and travel by aircraft. Consumption patterns with low GHG emissions are characterized by less spending on mobility, but more on leisure and quality oriented consumption leading to higher prices per unit [25]. Further characteristics are: a higher share of organic food, low meat consumption and fewer detached single-family houses. The study findings imply that a significant reduction in GHG emissions would be possible by adopting real-world consumption patterns observable in society. In EU-15 it was evaluate that total GHG emission reduction potential in household sector

Table 1
Daily agenda records during the warm year period according baseline scenario.

Time	Activities	Duration, h	Amount of energy used or waste accumulated	Coefficient	Formula for GHG emissions assessment	GHG emissions, kg of CO_2 equivalent
10:00–10:30	Cooking	0.5	0.1 m^3	2.19	0.1×2.19	0.22
10:45–14:15	Use of PC	3.5	Processor – 150 W Monitor – 100 W Hard disk 30 W Optical disk – 20 W Graphics card – 100 W Sound card – 30 W Hard disc– 30 W Total: 460 W	1/2*	$(3.5 \times 460)/2 \times 1000$	0.81
12:00–14:15	Watching TV	2.25	100 W	1/2*	$(2.25 \times 100) \times 2 \times 1000$	0.11
14:30–18:45	Car driving (distance 50 km)	4.25	5 l	1.64/2*	$(5 \times 1.64)/2$	4.1
18:45–00:05	Lighting	5.33	5×100 W	1/2*	$(5.33 \times 500)/2 \times 1000$	1.33
18:50–19:45	Cooking	0.92	0.17 m^3	2.19/2*	$(0.17 \times 2.19)/2$	0.19
19:55–19:59	Waste	0.07	1 kg	1/2*	$(1 \times 1)/2$	0.5
20:00–23:30	Use of PC and TV set	3.5	460 W	1/2*	$(3.5 \times 460)/2 \times 1000$	0.81
23:35–23:52	Use of shower	0.28		0.174	17×0.174	2.96
						11.03

makes about 190 Mt/year [32]. In Netherlands the comprehensive study indicated that 27% reduction of total annual GHG emission in country can be achieved in household sector by applying product and behavioral innovations [33,34]. The studies mentioned above used different approaches in assessing GHG emission reduction potential in households. Besides that in these studies GHG emission reduction potential from behavioral changes was not evaluated separately. The framework for assessing GHG emission reduction potential implied by behavioral changes in household sector was developed for Lithuania by applying results and findings from above described studies.

3. The framework for assessment of GHG emission reduction potential in households

The scenario approach was applied for assessing GHG emission reduction potential in household sector. The time spent for specific activity has been recorded and consumed energy (electricity, gas, and gasoline) is assessed for baseline and GHG emission reduction scenario for households participating in survey. Based on this data the energy consumed has been multiplied by specific coefficient (carbon foot print) and GHG emissions for each activity were evaluated [35]. Specific coefficients were obtained from Carbon Calculator available on website developed by EU campaign "You control climate change". The aim of the study was to calculate how many kg of CO_2 can be saved each year in households sector by changing life style and at no costs [11].

Having such type of data it is possible to evaluate GHG emission reduction potential in all household sectors in Lithuania taking into account of the population size of the country [11]. The main uncertainties of such type of assessment are related with differences of population income and living standards, location, education, background, dependence to specific social group, age, sex, profession, concern about environment all having impact on specific habits and life style. The survey was conducted by MSc students during one year. 50 households were surveyed [11]. The cold year period is from 1st October to 31st of March. The warm year period is accordingly from 1st April until 31st September. Energy saving is focused on changes of life style and is not related with investments in energy saving equipment or house insulation. Therefore all avoided GHG emission can be achieved free of charge.

The main algorithm applied in GHG emission reduction potential assessment in households is presented bellow.

GHG emission during half a year for baseline scenario was evaluated based on Eq. (1):

$$E_{1w} = S_{1w} D_w G \tag{1}$$

Here E_{1w} is the GHG emissions in households according baseline scenario during warm year's period; S_{1w} is the daily GHG emissions per capita during warm year period according baseline scenario; D_w is the total amount of the days during the warm year period; G is the population size adjusted taking into account the size of disabled and infants.

GHG emission during half a year according GHG emission reduction scenario were evaluated applying Eq. (2):

$$E_{2w} = S_{2w} D_w G \tag{2}$$

Here E_{2w} is the GHG emissions in households according GHG emission reduction scenario during the warm year's period; S_{2w} is the daily GHG emissions per capita during warm year period according GHG emission reduction scenario; D_w is the total amount of the days during the warm year period; G is the population size adjusted taking into account the size of disabled and infants.

Avoided GHG emissions in households sector during the warm year period because of energy saving and changes in life style are evaluated based on Eq. (3):

$$M_w = E_{1w} - E_{2w} \tag{3}$$

Here M_w is the avoided GHG emissions during the warm year period. In analogous way avoided GHG emissions were evaluated for cold period of the year M_c based on Eq. (4):

$$M_c = E_{1c} - E_{2c} \tag{4}$$

Total avoided GHG emissions in households were evaluated by summing up GHG emission avoided during warm and cold year period:

$$P = M_w + M_c \tag{5}$$

Here P is the total annual GHG emissions reduction potential in households because of energy saving and changing life style.

In the following Table 1 the example of daily agenda record of one family is presented during warm year period according the baseline scenario. In daily agenda records the time, the main activities, they duration have been recorded. Based on these records the amount of energy used or waste accumulated was evaluated. Having such data it is possible to assess GHG emission because

Table 2
GHG emission coefficients.

Coefficient	Description
2.193	This coefficient was applied for assessment of GHG emissions during cooking. It indicates the amount of GHG emissions by burning 1 m^3 of natural gas
1	This coefficient is applied for the evaluation of GHG emissions during consumption of electricity. It indicates the amount of GHG emissions during 1 kWh of electricity consumption
1.64	This coefficient was applied for assessment of GHG emissions during the car driving. It indicates the amount of GHG emissions during 1 km of car driving. It is assumed that to drive 10 km 1 l of gasoline is necessary
1	This coefficient was applied for the assessment of GHG emissions because of waste accumulation in households. It indicates the amount of GHG emissions because of 1 kg waste accumulation
0.174	This coefficient was applied for the assessment of GHG emissions during warm water consumption. It indicates GHG emissions for 1 min of showering at water speed 0.28 l/min

of energy consumption or accumulated waste by applying specific GHG emission coefficients presented in Table 2.

The main coefficients applied in GHG emission assessment are presented in Table 2. Based on information presented in Table 2 average daily GHG emissions per household during the warm year period make about 11.03 kg CO_{2eq} according baseline scenario.

Total GHG emissions during the warm year period according baseline scenario are evaluated according Eq. (1):

$$E_{1w} = 11.03 \times 182.5 \times 3,045,000 = 2012.98 \times 3,045,000$$
$$= 6,129,508,875\,\text{kg} = 6.13\,\text{Mt}$$

GHG emission during the same period according GHG emission reduction scenario was evaluated in Table 3.

During GHG emission reduction households who conducted the daily survey were trying to change and save lifestyle as much as possible energy and **s**ort the waste. The main changes of life style were associated with using bicycle or walking instead of driving car, reducing waste by sorting and selecting appropriate packing and buying intelligently, switching the light and computer or TV set when it is not needed, turning off tap while brushing the teeth, using shower instead of bath and reduce time spent under the shower, not leaving appliances on standby, unplugging the mobile charger when it is not being used, boiling less water when cooking, cover pots while cooking, etc. These simple changes of life style described in details on website "http://ec.europa.eu/environment/climat/campaign/index.htm" can allow avoiding quite large amounts of GHG emissions as one can see from Table 3.

Total GHG emissions during the warm year period according GHG emission reduction scenario then energy saving and waste reduction measures were applied is evaluated according Eq. (2):

$$E_{2w} = 5.76 \times 182.5 \times 3,045,000 = 1051.2 \times 3,045,000$$
$$= 3,200,904,000\,\text{kg} = 3.2\,\text{Mt}$$

Therefore avoided GHG emissions in households sector during the warm year period because of energy saving and changes in life style are evaluated according Eq. (3):

$$M_w = 6.13 - 3.2 = 2.93\,\text{Mt}$$

The daily records and evaluated GHG emissions in household during cold year period according baseline scenario are presented in Table 4.

As one can see from Table 4 GHG emissions during cold year period are higher because of longer lighting period and electric appliances use. Total GHG emissions in households according baseline scenario during the cold year period were evaluated for the cold period according Eq. (1):

$$E_{1c} = 12.33 \times 182.5 \times 3,045,000 = 2250.23 \times 3,045,000$$
$$= 6,851,935,125\,\text{kg} = 6.85\,\text{Mt}$$

The daily records and evaluated GHG emissions in household during cold year period according GHG emission reduction scenario are presented in Table 5.

Total GHG emissions in households according GHG emission reduction scenario during the cold year period were evaluated for the cold period according Eq. (2):

$$E_{2c} = 7.43 \times 182.5 \times 3,045,000 = 1355.98 \times 3,045,000$$
$$= 4,128,943,875\,\text{t} = 4.13\,\text{Mt}$$

Therefore avoided GHG emissions in households sector during the cold year period because of energy saving and changes in life style are evaluated according Eq. (4):

$$M_c = 6.85 - 4.13 = 2.72\,\text{Mt}$$

Total avoided GHG emissions in households because of changing life style and saving energy and reducing waste are evaluated according Eq. (5):

$$P = 2.93 + 2.72 = 5.65\,\text{Mt}$$

In the following chapter GHG emission reduction potential in households sector obtained will be compared with GHG emission reduction potential in other sectors of economy.

4. GHG emission reduction potential in Lithuania

The results of households survey conducted indicated that total annual GHG emissions in household according the baseline scenario in Lithuania amounted to 12.98 Mt. The approximate annual GHG emission reduction potential because of changing life style and saving energy and reducing waste makes about 5.65 Mt in Lithuania. In National energy efficiency programme adopted in 2007 [36], total annual GHG emission reduction potential evaluated in household sector makes just 1.312 Mt CO_{2eq} and is significantly lower.

There are already implemented and foreseen climate change mitigation policies and measures implemented in Lithuania mainly targeting increase use of renewable energy sources and energy efficiency improvements in industry and energy generation sector [37,38]. GHG emission reduction potential evaluated in Lithuania in Report demonstrating progress under the Kyoto protocol [39,40] is presented in Table 6.

The annual GHG emission reduction potential in fuel combustion sector in 2010 makes just 1.9 Mt, in industry – 2.4 Mt. The total GHG emission reduction potential in Lithuania in 2010 makes about 5.94 Mt without LULUCUF. Therefore total evaluated GHG emission reduction potential in Lithuania is very close to possible GHG emission reduction in households because of energy saving and waste reduction −5.65 Mt.

In Lithuania because of the closure of the second unit at Ignalina NPP in 2009 it expected that GHG emissions would increase about 5 Mt/year [41]. There is decision to built new nuclear power plant in Lithuania up to 2015–2017. Construction of new nuclear power in Lithuania would allow to reduce GHG emissions by 5–6 Mt/year therefore it is not necessary to built new nuclear power seeking to reduce increased GHG emission because of the closure of the

Table 3
Daily agenda records during the warm year period according GHG emission reduction scenario.

Time	Activities	Duration, h	Amount of energy used and waste accumulated	Coefficient	GHG emissions, kg of CO_2 equivalent
10:00–10:30	Cooking	0.5	0.1 m^3	2.19	0.22
10:45–12:15	Use of PC	1.5	460 W	1/2*	0.35
12:00–13:00	TV watching	1	100 W	1/2*	0.05
13:00–14:45	Car driving (distance 15 km)	1.25	1.7 l	1.64/2*	1.23
14:45–18:45	Cycling	4	0	0	0
19:05–00:05	Lighting	5	4 × 100 W	1/2*	1
18:50–19:45	Cooking	0.92	0.17 m^3	2.19/2*	0.19
19:55–19:59	Waste	0.07	0.8 kg	1/2*	0.4
20:00–22:30	Use of PC and TV set	2.5	460 W	1/2*	0.58
23:35–23:45	Shower	0.16		0.174	1.74
ΣCO_2 emissions, kg					5.76

Table 4
Daily agenda records during the cold year period according baseline scenario.

Time	Activities	Duration, h	Amount of energy used and waste accumulated	Coefficient	GHG emissions, kg of CO_2 equivalent
09:00–09:45	Cooking	0.75	0.135 m^3	2.19	0.3
10:00–14:00	Use of PC	4	460 W	1/2*	0.92
11:00–14:00	TV set	3	100 W	1/2*	0.15
14:10–16:45	Car driving (distance 50 km)	2.58	5 l	1.64/2*	4.1
16:45–00:05	Lighting	7.33	5 × 100 W	1/2*	1.83
18:00–19:30	Cooking	1.5	0.27 m^3	2.19/2*	0.3
19:45–19:50	Waste	0.08	1 kg	1/2*	0.5
18:00–23:30	Use of PC and TV set	5.5	460 W	1/2*	1.27
23:35–23:52	Shower	0.28		0.174	2.96
ΣCO_2 emissions kg					12.33

Table 5
Daily agenda records during the cold year period according GHG emission reduction scenario.

Time	Activities	Duration, h	Amount of energy used and waste accumulated	Coefficient	GHG emissions, kg of CO_2 equivalent
09:00–09:45	Cooking	0.75	0.135 m^3	2.19	0.3
10:00–13:00	Use of PC	3	460 W	1/2*	0.69
11:00–13:00	Watching TV	2	100 W	1/2*	0.1
14:10–16:00	Car driving (distance 17 km)	2.58	3 l	1.64/2*	1.39
16:45–00:05	Lighting	7.33	4 × 100 W	1/2*	1.47
18:00–19:30	Cooking	1.5	0.27 m^3	2.19/2*	0.3
19:45–19:50	waste	0.08	0.8 kg	1/2*	0.4
19:00–23:30	Use of PC and TV set	4.5	460 W	1/2*	1.04
23:35–23:45	Shower	0.16		0.174	1.74
ΣCO_2 emissions, kg					7.43

Table 6
Impact of policies and measures in 2010, 2015, 2020 and 2025, Mt.

Climate change mitigation policies and measures	The average annual GHG emission reduction, Mt			
	2010	2015	2020	2025
Fuel combustion sector				
Energy savings	0.18	0.51	0.84	1.18
Use of waste energy resources (conversion factor to primary energy 0.5)	0.22	0.3	0.38	0.45
Use of biofuels in transport (conversion factor to primary energy 1.076)	0.17	0.32	0.47	0.62
RES in electricity generation (conversion factor from electricity to primary energy 2.707)	0.54	0.66	0.78	0.9
Cogeneration (conversion factor to primary energy 0.5)	0.29	0.36	0.43	0.51
RES in primary energy supply except categories already mentioned	0.5	0.61	0.72	0.84
Total in fuel combustion sector	1.9	2.79	3.62	4.5
Agriculture				
State programme for pollution to water reduction from agriculture sources	0.7	1.2	1.7	2.2
Waste				
National Strategic waste management plan	0.94	0.31	0.81	2.44
Industrial processes				
The wet cement production technology replacement by dry cement production technology	0.5	0.5	0.5	0.5
Modernization of technological processes in chemical industries of Achema	1.9	1.9	1.9	1.9
Total in industrial sector	2.4	2.4	2.4	2.4
Forestry Expansion Strategy for 2004–2020	7	7.63	8.26	8.9
LULUCUF				
Total with LULUCUF	12.9	14.3	16.79	20.44
Total without LULUCUF	5.94	6.67	8.53	11.54

second unit of Ignalina NPP first of all cheap or no cost measures should be implemented in households sector which would help to reduce significantly GHG emission in the country.

In the following chapter recommendations for GHG emission reduction measures in households sector will be developed for Lithuania based on studies conducted in other countries.

5. Measures to promote household behavioral changes towards sustainable consumption

Though a little progress has been made in developing GHG mitigation policies targeting household's behavioral changes towards sustainable consumption several studies provide valuable results in this field. The intervention studies conducted to date have primarily attempted to influence population behavior by targeting individual-level factors. The large majority of studies used communication to influence individual-level drivers of population behavior. From several review articles [25,23,42,43] it can be deduced that just some information programs on energy reduction are effective [44]. Another important conclusion in these reviews is that the information that is given should be personalized. This holds for reduction options given to the consumers as well as for the feedback on their changed behavior. There are several modes of communication having promising ability to reduce energy use summarized from studies reviewed:

- The provision of tailored or customized recommendations – based on home energy audits – can provide for energy use reductions in households in the range of 4–21%. An example of personal information in an energy conservation context is the home energy audit. This audit is a home visit by an expert on home energy savings. This expert gives personal advice for reducing energy in several ways, often focused on energy for space heating. 21% of average reduction compared with the control group in an energy audit study was obtained [45].
- The provision of feedback (i.e., specific information about the amount of energy being used) – especially when the feedback is frequent or continuous – can reduce households energy consumption in the range of 5–13% [25]. Feedback is the other form of personalized information. The advantage of feedback in this context lies in the chance for households to see the relationship between their behavior and their energy requirements.
- Encouraging people to set an energy reduction goal – especially if they are given feedback about their progress towards the goal can significantly reduce household energy consumption. G. Brandon and A. Lewis measured an average energy reduction of 1.36% as compared to a 7.78% increase for the control group. In this experiment, a group of 120 households (divided into seven groups) received different forms of feedback on their gas and electricity consumption [30].
- The communication campaigns promoting household energy savings impact has ranged from no behavior change at all to a relatively great deal of public and household change. The more successful campaigns typically used what are now commonly accepted as good campaign design practices: simple clear messages, repeated often (e.g., through a variety of interpersonal and media channels, electronically and in print), by a variety of trusted sources (e.g., scientists, community leaders, and journalists). Using mass media (TV) to model ways to reduce household electricity use can achieve about 10% reduction in household electricity use [25].
- Eco-labeling programs have been shown to influence population behavior – at least some people's behavior under certain conditions. People who hold pro-environmental attitudes are most likely to be influenced. The effectiveness of eco-labeling programs tends to increase over time as consumers develop trust in the labeling system [17].
- Marketing interventions – in which improvements are made to products or services, their prices and availability, and how they are promoted (to enhance their perceived value to potential customers) – have also shown promise as tools for population behavior management with a variety of climate change–relevant behaviors.
- More informative energy bill provided more frequently (six times instead of 1/year) can reduce about 10% of energy consumption in households [25]. The extra information comprised a simplification of the bill, a comparison with last year's energy bill, and some energy-saving tips.

In general, it can be concluded based on recent studies results [17,20,22–25] that not all experiments carried out on energy reduction in households are successful, but that those in which feedback and a more personalized approach are used give the best results; therefore, the main recommendations for reshaping of Lithuanian climate change mitigation policy are the following: provide information campaigns on energy saving and GHG emission reduction measures at no costs for households using mass media, social advertisement measures, to establish institutions responsible for providing information on energy savings and conducting home energy audits on customers request. Provision of tailored information based on home energy audits is the most effective measure to change consumption behavior and needs to be available for Lithuanian households. The feedback and encouraging people to set an energy reduction goal are especially effective measures, which are also not available for Lithuanian households. More informative energy bills need to be established for Lithuanian customers as well. Therefore, there are a lot of quite cheap GHG reduction measures which can be applied on demand side in Lithuania. The most important issues are related with information dissemination and encouraging customers to change life styles to more sustainable.

6. Conclusions

1. The potential impact of lifestyle and tradition on energy use and GHG emission reduction potential has been evaluated in various studies. IPCC states that changes in life style and behavior patterns can significantly contribute to climate change mitigation. At the same time Lithuanian climate change mitigation policy is targeting mainly energy supply sector and promotes mainly price initiatives for GHG emission reduction.
2. Annual GHG emission reduction potential in Lithuania households sector based on National energy efficiency programme [36] makes about 0.52 TWh. Evaluated GHG emission reduction potential in households sector makes 1.312 Mt CO_2 per year in Lithuania according this document however the survey conducted by MCs programme students at Vilnius University in 2009 indicated that the changes of life style can allow to reduce GHG emission in households without any additional investments about 5.65 Mt in Lithuania.
3. The evaluated total annual GHG emission reduction potential in Lithuania in 2010 makes about 5.94 Mt without LULUCUF. Therefore total evaluated GHG emission reduction potential in Lithuania is very close to possible GHG emission reduction in households because of energy saving and waste reduction −5.65 Mt.
4. In Lithuania because of the closure of the second unit at Ignalina NPP in 2009 it expected that GHG emissions would increase about 5 Mt/year. There is decision to build new nuclear power plant in Lithuania up to 2015–2017. Construction of new nuclear power in Lithuania would allow to reduce GHG emissions by

5–6 Mt/year therefore it is not necessary to built new nuclear power seeking to reduce increased GHG emission because of the closure of the second unit of Ignalina NPP. First of all cheap or no cost measures should be implemented in households sector which would help to reduce significantly GHG emission in the country.

5. Policies targeting behavioral changes in household needs to be implemented in Lithuania seeking to achieve international GHG emission reduction targets at lower costs. These are information campaigns on energy saving and GHG emission reduction measures at no costs for households using mass media and social advertisement measures, establishment of institutions responsible for providing information on energy savings and conducting home energy audits on customers request, provision of tailored information and feedback based on home energy audits, setting more frequent and more informative energy bills for customers, etc.

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